Chapter 11 Design Standards

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CHAPTER 11 DESIGN STANDARDS

11.1 INTRODUCTION

General

Project construction plans and specifications must provide for a facility that will adequately meet the existing and probable future traffic in a manner conducive to safety, project economics, durability and economy of maintenance. The design standards used for any project should equal or exceed the minimum standards given in this chapter. Taking into account costs, traffic volumes, traffic and safety benefits, right of way, socio-economic; and environmental impacts allows for the use of lower standards only when such use best satisfies the given situation. All exceptions from accepted standards must be justified, documented and retained in the project files.

The purpose of this chapter is to:

- Designate "Statewide" design standards, criteria, specifications, procedures, guides, and references that are acceptable for application in the geometric, structural, drainage and pavement design of local federal-aid projects both on and off the National Highway System (NHS).
- Describe the procedures to allow the use of "certain locally developed" design standards, including standard specifications and standard plans, as acceptable alternatives to "Statewide" design standards for local federal-aid projects off the NHS.
- Outline the "Design Exception" approval procedures for local federal-aid projects on and off the NHS.

Definitions

Alteration – An alteration, as applicable to Americans with Disabilities Act (ADA) is a change to a building or facility including roadway made by, on behalf of, or for the use of a public accommodation or commercial facility that affects, or could affect the usability of the building or facility, or part thereof. Alterations include, but are not limited to, remodeling, renovation, rehabilitation, reconstruction, historic restoration, changes or rearrangement of the structural parts or elements, and changes or rearrangement in the plan configuration of walls and full-height partitions. Normal maintenance including filling potholes, reroofing, painting or wallpapering, or changes to mechanical and electrical systems are not alterations unless they affect the usability of the building or facility.

Design Standards -- The standards, specifications, procedures, guides and references listed herein that are acceptable for application in the geometric, structural, pavement and hydraulic design of local federal-aid projects.

Controlling Criteria -- The specific minimum criteria and controls contained in the design standards that are of primary importance for safety. Deviations from these controlling criteria require design exception approval in accordance with Section 11.4 of this chapter.

Design Exception Approval -- A process to justify, approve, and document allowable deviations from controlling criteria.

Specifications -- The directions, provisions, and requirements contained in the contract documents for a specific construction project. Included are various proposal conditions, contract administration provisions, required construction methods, and technical requirements for materials.

Standard Specifications -- A published document that contains commonly used specifications developed for use as a reference for construction contract documents.

Standard Plans -- A collection of plan details developed for use as a reference for construction contract documents. Included are standard abbreviations, symbols, design notes, design conditions and data, construction details, specifications, layouts, and measurement and payment details.

Types of Construction:

1. New Construction - Is defined as a new transportation facility that did not previously exist in the corridor or as the addition of an interchange. The addition of appurtenances to an existing facility, such as striping, signs, signals, noise barriers, etc. is not considered new construction.
2. Reconstruction (as defined for Stewardship purposes)- Involves the following:
    - Addition of a lane (except climbing or auxiliary lanes)
    - Significant change in horizontal and/or vertical alignment
    - Reconstruction of an interchange by adding moves or relocating ramps (widening ramps for storage, turning movements or ramp metering are not included)
    - Replacement of an entire bridge or the major parts of an existing bridge (in such a manner that it is effectively a new bridge)
    - Seismic retrofit projects for the following:
        a) Major or unusual structures (all tunnels, unusual and movable bridges, unusual hydraulic or geotechnical structures, or bridges with a total deck area greater than 125,000 square feet), or
        b) Construction cost greater than $5 million per structure
    - Major modifications to Traffic Management Centers
3. Preventive Maintenance -- Includes, but is not limited to, roadway activities such as joint and shoulder rehabilitation, heater re-mix, seal coats, corrective grinding of PCC pavement, and restoration of drainage systems.
4. 3R Work -- All other work which do not fall into the above defined categories for new construction, reconstruction or preventive maintenance and typically involves the improvement of highway pavement surfaces through resurfacing, restoration, or rehabilitation. Specifically, 3R Work is defined as the following:
    - Resurfacing generally consists of placing additional asphalt concrete over a structurally sound highway or bridge that needs treatment to extend its useful service life.
    - Restoration means returning a road, structure, or collateral facility to the condition existing after original construction.
    - Rehabilitation implies providing some betterments, such as upgrading guardrail or widening shoulders.

The 3R work is generally regarded as heavy, nonroutine maintenance work designed to preserve and extend the roadway service life for at least ten years as well as upgrading to enhance safety where reasonable. It differs from new construction or reconstruction in that it does not comtemplate capacity improvements, major realignment or major upgrading of geometric features or standards. However, the work may include selective improvements to highway geometry and other roadway features including safety appurtenances, and still be considered 3R work (please refer to Design Information Bulletin 79-02 available at the following website: http://www.dot.ca.gov/hq/oppd/dib/dibprg.htm).

11.2 Statewide Design Standards for Local Assistance Projects

The following statewide design standards are acceptable for design of local federal-aid projects both on and off the NHS.

Locally funded projects on the State Highway System (SHS) must be designed in accordance with SHS standards as defined in various Caltrans manuals.

Roadway and Appurtenances

Geometric Standards for New and Reconstruction Projects

New and reconstruction projects shall be designed in accordance with American Association of State Highway and Transportation Officials (AASHTO) Standards as defined in the current edition of *A Policy on Geometric Design of Highways and Streets* (often referred to as the *AASHTO Green book*).

The Federal Highway Administration (FHWA) has designated twelve (12) geometric controlling criteria with a primary importance for safety in the selection of design standards. These criteria are:

- Design Speed
- Lane Width
- Shoulder Width
- Bridge Width
- Horizontal Alignment
- Vertical Alignment
- Grades
- Stopping Sight Distance
- Cross Slopes
- Superelevation
- Horizontal Clearance
- Vertical Clearance

The FHWA has indicated that any deviations from these geometric controlling criteria requires formal approval. Such deviations from the above criteria requires that a local agency obtains design exception approval in accordance with the procedures described in Section 11.4, “Design Exceptions,” in this chapter.

Geometric Standards for 3R Projects

The minimum standards for geometric design of local federal-aid resurfacing, restoration and rehabilitation (3R) projects, are shown in Tables 1 through 10 of Exhibit 11-A, “Geometric Standards for Local 3R Projects” (see DIB 79-02 for geometric standards for 3R projects on National Highway System). Designs using better than minimum standards should be used when feasible especially in areas of high traffic volume; when design speeds exceed 50 mph; and when significant truck volumes are expected.

The primary purpose of 3R projects is to preserve and extend the service life of existing facilities and enhance highway safety, normally, without major improvements to existing geometric features. However, a reasonable effort should be made to provide uniform geometric standards for a substantial length of roadway. Therefore, the work may include upgrading of geometric features, such as minor roadway widening, flattening curves or improving sight distances and still be considered as 3R work.

Lane and Shoulder Widths-- Tables 1, 2 and 3 of Exhibit 11-A present the minimum 3R standards for widths of traffic lanes and shoulders on roadways classified as arterials, collectors and local roads and streets.

Table 4 presents the minimum 3R standards for traffic, turning, parking, and bicycle lanes for urban streets and roads with curb and gutter.

Wide lanes and shoulders give motorists: 1) increased opportunity for safe recovery when their vehicles run off the road, and 2) increased lateral separation between overtaking and meeting vehicles. Added safety benefits include improved site distance at critical horizontal curves, reduced interruption from emergency stopping and road maintenance activities, less wear at the lane edge, and better roadway surface drainage.

Traffic volumes influence the cost-effectiveness of lane and shoulder widening, because the number of accidents eliminated by lane and shoulder widening increases almost in proportion to an Average Daily Traffic (ADT), whereas the costs are not affected significantly by ADT. Lane and shoulder widening can also produce timesavings for highway users, which can be an important consideration for highways with an ADT greater than 2,000 vehicles per day.

Bridge Widths -- The minimum bridge width values for 3R projects involving bridges to remain in place on arterial, collectors, and local streets and roads are shown in Tables 5, 6, and 7 of Exhibit 11-A. The 3R projects on such bridges involve mainly roadway resurfacing and improvements to railings. More significant work, such as structural strengthening, or deck replacement is classified as reconstruction and must meet AASHTO standards.

The relationship between bridge width and the width of approach lanes influences bridge safety; roadway constriction at narrow bridges reduces the opportunity for safe recovery by out-of-control vehicles, and may result in collisions with bridge abutments.

Thus, the safety cost-effectiveness of bridge width improvements depends upon the usable width of the bridge, the width of the approach lanes, traffic volumes, and the length of bridge.

Horizontal Clearance – Side slope and clear zone improvements on 3R projects should meet the following criteria:

1. Flatten side slopes of **1**(v)**:4**(h), or steeper at locations where run-off-the-road accidents are likely to occur, such as on the outside of sharp horizontal curves.
2. Whenever possible, side slopes should not be steepened when widening lanes and shoulders.
3. Remove, relocate, or shield isolated roadside obstacles.

Roadside characteristics are important in determining the overall level of safety provided by a highway. Accident rates are lower, and accidents are less severe on highways with gentle side slopes and fewer obstacles near the roadway.

Removing isolated trees, and relocating utility poles can be more safety cost-effective than widening lanes or flattening horizontal curves.

Horizontal Alignment -- Values for stopping sight distance and horizontal curves for 3R projects are shown in Tables 8, 9 and 10 of Exhibit 11-A.

Safety often can be improved at horizontal curves without costly reconstruction. Local agencies should evaluate other safety measures when reconstruction is unwarranted. Such measures might include widening lanes, widen and paving shoulders, flattening steep side slopes, removing or relocating roadside obstacles, and installing traffic control devices, raised pavement markings and reflective guideposts.

Accidents are more likely to occur on horizontal curves than on straight segments of roadway because increased demands are placed on the driver and vehicle, and centrifugal force tends to cause a vehicle to run-off-the road. The safety effect of an individual curve is influenced not only by the curve's geometric characteristics, but also by the geometry of adjacent highway segments. Safety considerations are important especially when a curve is unexpected, such as when it follows a long straight approach, or when it is hidden from view by a hillcrest.

Depending on site conditions, improvements to curves can be an inexpensive and effective means of reducing the severity and frequency of accidents.

Vertical Alignment -- Values for superelevation, grades and stopping sight distances are included in Tables 8, 9 and 10 of Exhibit 11-A. For sustained downgrades, consideration should be given to increasing the minimum stopping sight distances shown in the above tables.

The Transportation Research Board recommends that local agencies evaluate the option of reconstructing hillcrests when:

1. The hillcrest hides from view such conditions as: intersections, sharp horizontal curves or narrow bridges.
2. The Average Daily Traffic is greater than 1,500 vehicles per day.
3. The design speed of the hillcrest (based upon the minimum sight distance provided) is more than 20 mph below the 85th percentile speeds of vehicles on the crests.

Whether, or not the reconstruction of a hillcrest is necessary, designers should examine the nature or potential hazards hidden by a hillcrest, and consider other options such as removing potential hazards or providing warning signs.

Sight obstructions at hillcrests can be corrected only by changing the vertical alignment to lengthen the existing vertical crest curve.

Generally, to be safety and cost-effective, vertical alignment improvements must correct a substantial sight distance restriction that affects a driver's ability to anticipate difficult situations, such as turning vehicles, sharp curves, or other conditions that demand specific driver responses.

Pavement Crown and Edge Drops -- Local agencies performing resurfacing projects should consider constructing pavement overlays with pavement crowns that match AASHTO standards for new construction.

Resurfacing projects offer opportunities to improve surface drainage and vehicle control in wet weather, by correcting deficient cross slopes at little or no additional cost.

Pavement edge drops result either from resurfacing activity unaccompanied by desirable shoulder improvement, or from wear, or erosion of weak shoulder material. Resurfacing can increase the likelihood that edge drops will develop later and require repeated maintenance to correct.

Consideration should be given to paving shoulders selectively to improve all-weather use and prevent edge drop problems from occurring on either the inside of outside of a short radius curve.

Pavement Structural Section

The design of a pavement structural section is not an exact science. The design guidelines and standards referenced herein are based on a wide range of factors. The final pavement design must be based on a thorough investigation of specific project conditions including materials, environmental conditions, projected traffic, life-cycle economics, and the performance of other like pavement structural sections under similar conditions in the same area.

The structural section of the roadbed should conform to:

- Section 600 of the *Caltrans Highway Design Manual*,
- *Caltrans Flexible Pavement Structural Section Design Manual*, or
- *Flexible Pavement Structural Section Design Guide for California Cities and Counties*, published by Caltrans in cooperation with County Engineers Association of California and the League of California Cities.

Signs and Markings

Guidance, regulatory, warning and temporary traffic control signs, curb and pavement, or other markings, markers, and traffic signals installed, or placed on any project constructed with federal funds shall conform to the *Manual on Uniform Traffic Control Devices* (MUTCD) and *MUTCD California Supplement*.

The FHWA has indicated that school crosswalks and other school markings should conform to the MUTCD in the interest of national uniformity when transverse crosswalk lines are used. The crosswalk markings shall be solid white or yellow; as required by California law and as stated in the *MUTCD California Supplement*, *Part 7, Traffic Controls for School Areas*. The MUTCD and *MUTCD California Supplement* are respectively available at:

http://mutcd.fhwa.dot.gov/ser-pubs.htm

http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/index.htm

Deviations from the “Mandatory Standards” for signs markings, and traffic signals as defined and shown in the MUTCD and the *MUTCD California Supplement* are not permitted; unless a proposal to experiment with non-standard devices is submitted to the California Traffic Control Devices Committee and approved for experimental use.

Intelligent Transportation Systems/Traffic Signal Controllers

Per 23 Code of Federal Regulations (CFR), Part 940, *Intelligent Transportation System Architecture and Standards*, effective April 8, 2001, all Intelligent Transportation Systems (ITS) projects must adhere to ITS Standards. The choice of ITS Standards hinges on the development of a Regional ITS Architecture. See *Local Assistance Program Guidelines* (LAPG), Chapter 12.6 *Intelligent Transportation Systems*, section for details on ITS Standards, or website at: http://www.dot.ca.gov/hq/LocalPrograms/lam/lapg.htm.

Assembly Bill 3418 (1995) which amended Section 21401 of the *California Vehicle Code*, requires "any traffic signal controller that is newly installed or upgraded by the Department of Transportation or a local authority after January 1, 1996, shall be of a standard traffic signal communication protocol capable of two-way communications." Communication standards for traffic signal controllers are available from the National Transportation Communications for ITS Protocol. This information may be accessed through the Internet at: http://www.ntcip.org/. Other ITS elements to enhance pedestrian safety at intersections can be found at: http://www.walkinginfo.org/pedsmart/home.htm

Safety

The following publications have also been developed to aid the designer in improving highway safety:

- *Manual on Uniform Traffic Control Devices* (MUTCD)
- *MUTCD California Supplement*
- *Designing Safer Roads, Special Report 214*, Transportation Research Board
- *Roadside Design Guide, 1995* (availalble through AASHTO)

These publications are primarily informational or guidance in nature, and serve to assist local agencies in knowing the information valuable to attaining good designs. All designers should be familiar with these documents. Although the principles contained are written primarily for high-speed highway facilities, consideration should be given to their application on other types of projects regardless of traffic volumes and design speed. Project-by-project deviations from the criteria in these publications do not require handling in accordance with design exception approval procedures cited in Section 11.4 of this chapter. However, any deviations should be justified and documented in the project files.

Evaluating accident records is an integral step in developing highway projects and often reveals problems requiring special attention and corrective action. Accident records are available from the Statewide Integrated Traffic Records System (SWITRS) for analysis. Relative accident rates can influence the priorities of projects and ensure that project objectives and the scope of design are related to accident causes. In addition, it may be necessary to use a cost/benefit study and an investigation of accident experience, to determine, if the correction of an identified safety problem is cost-effective. Significant safety problems, such as narrow bridges or culverts, railroad crossings or fixed objects which are not cost-effective to correct, must be provided with suitable warning and traffic control devices. For example, no bridges may be left in place which have a width narrower than the surfaced approach roadway, unless suitable signing, marking and parapet protection are provided.

On many local agency projects, right of way considerations may limit the extent to which side slopes may be flattened and roadside clearances obtained. In such situations, it is expected that the desired smooth and obstacle-free roadside will be obtained to the extent feasible.

Bikeway Standards

The standards for bikeway projects shall conform to Chapter 1000 of the *Caltrans Highway Design Manual*. Deviations from the "mandatory" bikeway standards stated therein require approval in accordance with the design exception approval procedures described in Section 11.4 of this chapter.

Pedestrian Facilities

General Policy

Caltrans has the responsibility to ensure that all local agency projects, for which the local agency receives federal financial assistance from the US Department of Transportation, fully comply with 49 CFR (Code of Federal Regulations), Part 27 entitled, *Nondiscrimination on the Basis of Disability in Programs and Activities receiving or Benefiting from Federal Financial Assistance*. 49 CFR, Part 27 applies to each recipient of federal assistance from the US Department of Transportation, and to each program or activity that receives or benefits from such assistance.

Specifically, Caltrans' role is to ensure that all new and existing altered facilities such as, but not limited to highway rest area facilities, sidewalks, pedestrian cross walks, pedestrian over-passes, under-passes and ramps shall be made accessible to disabled persons in accordance with federal and state (the state should provide equal or greater accessibility) standards on all local agency federal-aid projects meeting the criteria for the ADA compliance as explained below.

In addition, local agencies are encouraged to adopt appropriate policies of the FHWA and Caltrans, e.g., *Accommodating Bicycle Pedestrian Travel*: *A Recommended Approach*, and Deputy Directive 64, *Accommodating Non-Motorized Travel*. This will help assure that the needs of non-motorized travelers are met in all programming, planning, construction, maintenance, operations, and project development activities and products.

Accessibility

Title II of the ADA of 1990 (http://www.usdoj.gov/crt/ada/reg2.html) prohibits discrimination on the basis of disability by public entities. This means that a public entity may not deny the benefits of its programs, activities, and services to individuals with disabilities because its facilities are inaccessible to these individuals. A public entity's services, programs, or activities when viewed in their entirety, must be readily accessible to, and usable by individuals with disabilities. This general requirement known as "program accessibility" applies to all existing facilities of a public entity. Under Title III (http://www.usdoj.gov/crt/ada/reg3a.html), public entities are not required to make each of their existing facilities accessible; as long as persons with disabilities have "equal access" to the goods and services provided to persons without disabilities.

Public entities may achieve program accessibility by a number of methods. In many situations, providing access to facilities through structural methods, such as alteration of existing facilities and acquisition or construction of additional facilities, may be the most efficient and equitable method of providing program accessibility. For example, to help achieve or maintain program accessibility, some local agencies have established an ongoing procedure for installing curb ramps upon request by individuals with disabilities.

The state and local governments are required to comply with either 28 CFR, Part 35, *Nondiscrimination on the Basis of Disability in State and Local Government Servic*es, or 28 CFR, Part 36, *Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities,* for all new construction and altering of existing improvements with or without federal-aid funds. Within the project limits, the design of the improvements shall comply with the current federal ADA regulations (*ADA Standards for Accessible Guidelines for Buildings and Facilities* (ADAAG) at Appendix A to 28 CFR, Part 36), and with the California and local building codes. For example, if a local agency is performing a pavement overlay (defined as an "alteration") of a street that has existing curb ramps; it will be necessary at that time to ensure that the curb ramps within the project limits are in compliance with current federal ADA standards. This is required in 28 CFR, Part 35, Section 35.151, *New Construction and Alterations,* and under current law even though the curb ramps may be scheduled to be modified at a later date in the local agency's transition plan.

If discrepancies are found between federal, state, or local requirements; the discrepancies should be brought to the attention of the District Local Assistance Engineer (DLAE). Generally, federal ADA requirements will prevail, unless the state or local requirements provide greater accessibility.

The "Accessible Parking" and "Curb Ramp" plans for disabled persons included in the *Caltrans Standards Plans* were developed for the use of Caltrans and are available to local agencies. The *Caltrans Standard Plans* are updated periodically to ensure compliance with both federal and state ADA standards.The curb ramps include a detectable warning surface (truncated domes).

Transition Plan

Where structural modifications are required to achieve program accessibility, a public entity (city, county, or State of California) with 50 or more employees is required by 28 CFR, Part 35, Section 150, *Existing Facilities,* to develop a transition plan within 6 months from January 26, 1992, setting forth the steps necessary to complete such modifications. A public entity shall also provide an opportunity to interested persons, including individuals with disabilities or organizations representing the same, to participate in the development of the transition plan by submitting comments. A copy of the transition plan must be made available for public inspection for a period of three years. If a public entity has responsibility or authority over streets, roads or walkways; its transition plan shall include a schedule for providing curb ramps or other sloped areas where pedestrian walkways cross curbs; giving priority to walkways serving local government offices and facilities, transportation and places of public accommodation, followed by walkways serving other areas.

In cases of administrative burden and undue financial hardship, which must be documented by a Department Head having budgetary authority and responsibility for spending decision making; the transition plan related to sidewalks and curbs might include some accessible transportation; as an option to fully meet all program compliance obligations. For example, designated accessibility arrival areas could be fully accessible in business districts with the remainder of the need relying on accessible transportation like accessible taxis and/or light rail service. The relational balance should be validated via the public participation process.

ADA Compliance of Project Plans and Specifications

State and local governments regardless of whether they receive federal funds are required to comply with the federal ADA Standards (ADAAG at: http://www.access-board.gov/adaag/html/adaag.htm), Title 24 of the California Code of Regulations which contain California building regulations, or local codes whichever provides the greatest access. Private-funded improvements within the public right of way are also required to comply with, whichever code offers the greatest access or protections to individuals with disabilities**.** The State of California has adopted regulations specifying that all buildings, structures, sidewalks, curbs and related facilities constructed in California by the use of state, county or municipal funds, or the funds of any political subdivision of the State; shall be accessible to and usable by persons with disabilities. The California Division of the State Architect (DSA), under the Department of General Services, is given responsibility for developing regulations and standards to ensure full accessibility. The intent of these regulations and standards are to prescribe no lesser a standard of accessibility or usability than provided by the federal ADA standards.

California Government Code Section 4450 and subsequent sections are designated as Chapter 7, *Access to Public Buildings by Physically Handicapped Persons.*" Section 4454 entitled, *Approval of Plans and Specifications*, requires:

(a) "*Where state funds are utilized for any building or facility subject to this chapter, or where funds of counties, municipalities, or other political subdivisions are utilized for the construction of elementary, secondary, or community college buildings and facilities subject to this chapter, no contract shall be awarded until the Department of General Services has issued written approval stating that the plans and specifications comply with the intent of this chapter.*"

(b) *Notwithstanding subdivision (a), for all transportation facilities, other than rail or transit stations, located within state highway rights of way, the Department of Transportation is authorized to issue the required written approval stating that the plans and specifications comply with intent of this chapter. If the Department of General Services, Division of the State Architect establishes a certified access specialist program, as described in Section 4459.5, specific to standards governing access to transportation facilities, the Department of Transportation shall within 180-days of establishment of the program begin using engineers certified through that program to verify that the Department of Transportation's standards, guidelines, and design exceptions comply with the intent of this chapter.*

Local agency plans and specifications with pedestrian facilities to be constructed with state funds (federal funds are not considered state funds) must be reviewed and approved by DSA with one exception. The one exception, is local agency plans and specifications of pedestrian facilities within the state highway rights of way , if not for rail and transit systems, can be reviewed and approved (certified) by Caltrans in place of DSA. Approval of the plans and specifications by DSA will require fees be paid directly to DSA. DSA regional offices can be found at this website:

http://www.dsa.dgs.ca.gov/UniversalDesign/default.htm

ADAAG Exceptions

The following provisions mentioned in part, are contained in ADAAG, Appendix A of 28 CFR, Part 36 and are available for the use of local agencies:

- *Paragraph 2. General*

  2.2. Equivalent Facilitation*. Departures from particular technical and scoping requirements of this guideline by the use of other designs and technologies are permitted where the alternative designs and technologies used will provide substantially equivalent or greater access to and usability of the facility.*

- *Paragraph 4.1.1 Application*

  (5) General Exceptions. (a) In new construction, a person or entity is not required to meet fully the requirements of these guidelines where that person or entity can demonstrate that it is structurally impracticable to do so. Full compliance will be considered structurally impracticable only in those rare circumstances when the unique characteristics of terrain prevents the incorporation of accessibility feature. If full compliance with the requirements of these guidelines is structurally impracticable, a person or entity shall comply with the requirements to the extent it is not structurally impracticable. Any portion of the building or facility which can be made accessible shall comply to the extent that it is not structurally impracticable.

- *Paragraph 4.1.6 Accessible Buildings: Alterations*

  (1)General. (j) Exception: In alteration work, if compliance with 4.1.6 is technically infeasible, the alteration shall provide accessibility to the maximum extent feasible. Any elements or features of the building or facility that are being altered and can be made accessible, shall be made accessible within the scope of alteration.

  Technically Infeasible means with respect to an alteration of a building, or a facility that has little likelihood of being accomplished, because of existing structural conditions that would require removing or altering a load-bearing member which is an essential part of the structural frame; or because other exiting physical or site constraints prohibit modification or addition of elements, space; or features which are in full and strict compliance with the minimum requirements for new construction and which are necessary to provide accessibility.

Encroachment Permits

Should an encroachment permit from Caltrans be needed by a local agency for a project; ADA compliance of the plans and specifications in accordance with *Caltrans Design Information Bulletin 82-01* will be required before an encroachment permit is issued.

Applicable Facilities

Based on federal and state laws and regulations, all newly constructed facilities must allow full accessibility with few exceptions. Facilities, defined in 28 CFR and 49 CFR Part 28, include but are not limited to all, or any portion of buildings, structures, roads, walks, passages, parking lots, etc. When existing facilities are being reconstructed or modified, the contract must also include work to make these facilities fully accessible. *Title II-6.6000* of the Department of Justice's, *Technical Assistance Manual*, further defines this, by stating that when streets, roads, or highways are newly built or altered; they must have ramps or sloped areas wherever there are curbs or other barriers to entry from a sidewalk or path. Likewise, when new sidewalks or paths are built, or are altered, they must contain curb ramps or sloped areas wherever they intersect with streets, roads, or highways.

ADA Design Assistances

DSA's regulations and building standards generally prescribe a standard of accessibility, or usability equal, or greater than provided by the federal *ADA Standards for Accessible Design* adopted by the United States Department of Justice and the Department of Transportation, to implement the Americans with Disabilities Act of 1990 (Public Law 101-336). DSA's website, including a current version of the "*DSA's California Access Compliance Reference Manual*," is located at:

http://www.dsa.dgs.ca.gov/universaldesign/default.htm

The U.S. Department of Justice and the Federal Access Board both have very comprehensive websites committed to accessible design. The websites include ADA design standards and a design guide. The websites are respectively located at:

http://www.ada.gov/ , and http://www.access-board.gov/indexes/pubsindex.htm

Bridges

Definitions

Bridge -- A structure including supports erected over a depression or an obstruction, such as a waterway, highway or railway, and having a track or passageway for carrying traffic, or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercroppings of abutments, or spring lines of arches or extreme ends of openings for multiple boxes–may include multiple pipes where the clear distance between openings is less than half of the smallest contiguous opening.

Bridge Length -- The greater dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between ends of bridge floors.

Bridge Roadway Width -- The clear width of structure measured at right angles to the center of the roadway between the bottom of curbs or, if curbs are not used, between the inner faces of parapet or railing.

This definition is the minimum acceptable to the FHWA and is generally more restrictive than the state's definition, which is included as follows for reference.

The Office of Structures Maintenance and Investigation assigns an official bridge number and name to all "Bridges" meeting the following minimum criteria:

- Structures of more than length, measured parallel to the roadway centerline (facilities which come within the limits of the bridge classification only because of their skew, shall not be carried as bridges).
- Other structures where periodic inspection with written reports are desired. This includes items such as very large retaining walls, large culverts not qualifying as bridges, and special structures.

Bridge Design Procedures

All local bridges on and off the NHS shall be designed in accordance with the current edition of the Caltrans *Bridge Design Specifications* manual available at this website:

http://www.dot.ca.gov/hq/esc/techpubs/updates/page/bds-toc.pdf

In addition to the twelve geometric controlling criteria discussed in the Caltrans *Bridge Design Specifications* manual, the FHWA has designated "bridge structural capacity" as the thirteenth controlling criteria with a primary importance for safety in the selection of design standards. Deviations from standards relating to "bridge structural capacity" are not permitted.

It is desirable that a minimum appraisal rating (code) of 6 be attained for bridges, as defined by Item 68 in the Appraisal Section of the U.S. DOT/FHWA publication entitled *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, or justification provided, as to why the minimum appraisal rating (code) of 6 was not attained.

The following Caltrans publications are also available to assist local agencies in designing their bridges:

- *Bridge Design Practice Manual*
- *Bridge Design Details*
- *Bridge Design Aids*
- *Bridge Memo to Designers*

The above publications may be purchased through the Caltrans' Publication Distribution Unit located at 1900 Royal Oaks Drive in Sacramento, California, 95815-3800, Phone: (916) 445-3520, Fax: (916) 342-8997 or website at:

http: caltrans-opac.ca.gov/publicat.htm.

Clear Width Design

For continuity and safety, the curb-to-curb corridor width should be continued across a bridebridge. Additional shoulder width should be also considered for pedestrian and bicyclist safety on the bridge. This additional shoulder width for safety is particularly important on urban collectors and arterials.

Seismic Design

The *Caltrans Bridge Design Specifications* manual reflects the requirements of the current edition of *AASHTO Standard Specifications for Highway Bridges*, modified by Caltrans to incorporate California seismic design as well as other requirements.

In addition to the above-referenced Caltrans bridge manuals and publications, the following design references are also available to those involved in seismic and retrofit design:

- *Seismic Design References* - Excerpts for the Caltrans Division of Structures Technical manuals compiling seismic design requirements
- *Memo to Designers 20-4,– Earthquake Retrofit Guidelines for Bridges*
- Various publications of design notes and research results by the University of California at Berkeley, San Diego and others. This information is used extensively in current practice and enables the industry to keep up with the very latest research results.
- Various computer programs have been developed by Caltrans personnel to assist in the analysis required in retrofit design. These programs are available to local agencies and consultants involved in retrofit design:

  a) Beams304 b) Col604n c) WFrame d) Frame407

  e) Nfoot f) Col702r g) XSection

The references discussed above which are not available from Caltrans' Publication Distribution Unit, are available from the Caltrans Structure Local Assistance Office at (916) 227-8038.

Railroad Bridges

Design loadings and geometrics for bridges carrying railroads and clearances for highway bridges spanning railroads shall conform to the *Caltrans Bridge Design Specifications*.

Bridge Railing

Bridge railing shall be designed in accordance with the current edition of *AASHTO's Guide Specifications for Bridge Railings.*

Although the FHWA has not designated bridge railing as a "controlling criteria" for safety (requiring formal approval), nevertheless, all deviations from accepted bridge railing standards and procedures in this publication should be justified and documented in the project files. Project-by-project deviations from the criteria in this publication do not require handling, in accordance with design exception approval procedures discussed in Section 11.4 of this chapter.

However, consideration should be given to the long-term effects as to the bridge traffic safety features. This is part of data to be collected and retained for FHWA's use per CFR Section 650.311. Specifically, this data is included in the Sufficiency Rating (see the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, published by FHWA), which is used in the HBP Program as a basis for establishing eligibility and priority for replacement and rehabilitation of bridges (CFR 650.409).

Refer to the above section entitled "Safety" for additional references and guidelines on the design of bridge approach guardrail and other safety features.

Bridges to Remain in Place

When local agencies make highway improvements, they must often decide whether or not to upgrade existing bridges. If the structures are otherwise compatible with the proposed work, the following criteria should be used:

- AASHTO's *A Policy on Geometric Design of Highways and Streets* provides the criteria for minimum structural capacities and minimum roadway widths for bridges to remain in place (refer to the table *Minimum Structural Capacities and Minimum Roadway Widths for Bridges to Remain in Place*). This table is applicable only when no modifications are made to the superstructure (asphalt concrete blankets of 1 inch thickness or less, attachment of guardrails at bridge approaches, and deck seals are not considered superstructure modifications). When changes to the superstructure are required, refer to the table entitled, *Minimum Clear Roadway Widths and Design Loadings for New and Reconstructed Bridges*.
- The structure clear width (traveled way plus shoulders) should be determined in conformance with AASHTO standards.
- Asphalt concrete thin blanket overlay (thickness of 1 inch or less) projects that cross structures without increasing the width of the approach roadway do not affect the geometric or design standards of an existing structure. A "cumulative or total" asphalt concrete overlay thickness of more than 3 inches, or any significant increase in width of pavement of any thickness requires that the structure be reviewed, to comply with all AASHTO design and geometric criteria. A total asphalt concrete thickness of more than 1 inch, but less than or equal to 3 inches, as well as, membrane deck seals should be considered on a case-by-case basis. Bridge rail height is one of design criteria that needs to be checked with overlays between 1 and 3 inches.
- All bridges within project limits or immediately adjacent to the project, shall be provided with standard approach railings.
- Timber structures may not be widened.

Design of Large Culverts

Reinforced concrete cast-in-place box culverts, concrete arch culverts, structural plate vehicular undercrossings, and structural plate arch culverts with cast-in-place footings and inverts require favorable foundation conditions. When the *Caltrans Standard Plans* are used for these culverts, the foundation material must be capable of supporting footing pressures indicated on the plan.

Special culvert designs are required when:

- Fill heights exceed those on the *Caltrans Standard Plans.*
- Fill heights exceed those in the tables of the *Caltrans Highway Design Manual.*
- Corner pressure exceeds values in Tables 854.3E and 854.4C of the *Caltrans Highway Design Manual.*
- Foundation material will not support the design soil pressure in the *Caltrans Standard Plans.*
- Culverts are subjected to unequal lateral pressures.
- Culverts exceed the sizes in the *Caltrans Standard Plans*.

All structures shall be proportioned for loads and forces outlined in the *Caltrans Bridge Design Specifications,* Section 3. "Loads."

The loading conditions outlined in this chapter have been developed for California to provide adequate capacity for all anticipated seismic loading conditions on underground structures. No additional allowances are required.

Foundation Investigation for Design

A foundation investigation and report by an Engineering Geologist or Civil Engineer specializing in soils engineering should be completed for all bridge and large culvert sites.This requirement may be waived, if the engineer in responsible charge of design determines that site conditions clearly indicate the report is unnecessary. This requirement for a foundation investigation and report must be waived on a project-by-project basis. The waiver must be signed by a California registered Civil Engineer and retained in the project files. Federal funds shall not participate in any construction change orders or claims relating to inadequate foundation investigations when such a waiver has been exercised. In addition, federal participation in future repair costs resulting from the inadequate foundation investigation will be made on a project-by-project basis.

All reports shall contain recommendations by the Soils Engineer or Engineering Geologist for specific design considerations for the site (see Exhibit 11-C, "Foundation Investigations," in this chapter).

Where pile support is anticipated in design, specific attention is directed to the *Caltrans Bridge Design Specifications*, Section 4.3.3, "Design Loads." The report should contain the data called for in Section 4.3.5, "Required Subsurface Investigations."

Drainage

General

The goal of hydraulic design for bridges and culverts is to convey surface and stream waters originating upstream of the drainage facility to the downstream side without causing objectionable backwater, excessive flow velocities, excessive scour, or unduly affecting traffic safety. The hydraulic drainage design criteria contained or referenced in this manual have been developed to accomplish this goal. However, state-of-the-art methods and procedures for the hydrologic analysis required to determine the severity and probability of occurrence of flood events are inherently ambiguous. Therefore, the drainage design criteria contained in this manual section is provided for guidance only and is not intended to establish legalor design standards, which must be strictly adhered to. The local agency must use discretion in applying the drainage criteria in order to design the most cost-effective drainage facility considering the importance of the transportation facility, safety, legal obligations, ease of maintenance, and aesthetics. For example, the selection of a design flood with a lesser or greater peak discharge may be warranted and justified by economic analysis (except that the approach roadway should not be inundated by the design storm).

An exception to the above discussion is the evaluation of encroachments on the base flood plain. Federal regulations (23 CFR 650.115) state that all such encroachments shall be evaluated to assess the costs and risks associated with the base flood (Q100) or overtopping flood, whichever is greater.

Definitions

Action - Any highway construction, reconstruction, rehabilitation, repair, or improvement.

Backwater - The rise in water surface elevation due to encroachment.

Base Flood - The flood or tide having only a one percent (1%) probability of being equaled or exceeded in any given year. It is also referred to as the 100-year flood (Q100).

Convey - Passage through, or bypass of, the structure without significant damage to encroachments within the flood plain.

Design Flood - The peak discharge (volume if appropriate), stage or wave crest elevation selected for the design of a facility located within a base flood plain. By definition through lanes will not be inundated by the design flood.

Encroachment - A facility and/or appurtenant feature located within the limits of a base flood plain.

Flood of Record - The greatest recorded flood in the drainage basin.

Flood Plain - Any of the following: (1) the valley area adjacent to a stream or river subject to inundation during periods of high water that exceed normal bank flow elevation, (2) an area adjacent to a lake, estuary, ocean or similar body of water subject to inundation by high water, high tides, surges, tsunamis or any combination of these, and (3) an area where the path of the next flood flow is unpredictable, as within the limits of a debris cone, an alluvial deposit, cone, or fan, a debris slope or a talus.

Flood Plain Values - Fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance, groundwater recharge, etc.

Freeboard - (1) The vertical distance between the lowest structural member of a bridge superstructure and the water surface elevation of the design flood. (2) The vertical distance between the water surface elevation of the design flood, and the tops of the sides of an open conduit designed to allow for floating debris, or any other condition, or emergency without overtopping the structure.

Overtopping Flood - The magnitude of flood at which the water ceases to be conveyed totally through the drainage structure. Flow may be over the highway through overflow channels, or structures provided for emergency relief, or escape to another flood plain.

Regulatory Floodway - The flood plain area that is reserved in an open manner by federal, state or local requirements (i.e., unconfined or unobstructed either horizontally or vertically), to provide for the discharge of the base flood so that the cumulative increase in water surface elevation is no more than a designated amount (not to exceed 1 foot as established by the Federal Emergency Management Agency [FEMA] for administering the National Flood Insurance Program). The physical limits of the floodway will however, vary based on federal, state, or local definition.

Risk - The consequences associated with the probability of flooding attributable to an encroachment. It shall include the potential for property loss and hazard to life during the service life of the highway.

Risk -Analysis - An economic comparison of design alternatives using expected total costs (construction costs-plus-risk costs), to determine the alternative with the least total expected cost to the public. It shall include probable flood-related costs during the service life of the facility for highway operation, maintenance and repair for highway-aggravated flood damage to other property, and for additional or interrupted highway travel.

Significant Encroachment - A highway encroachment and any direct support of likely base flood plain development that would involve one or more of the following construction or flood related impacts: (1) a facility which provides a community's only evacuation route or one that is needed for emergency vehicles, (2) a facility in an unstable stream bed or other dangerous location, and (3) a facility that might have a significant adverse impact on natural beneficial flood plain values. It is federal policy to discourage any proposal that includes a significant encroachment.

Hydraulic Design Criteria

BRIDGES:

- The basic rule for hydraulic design of bridges is that; they should be designed to pass the two percent (2%) probability flood or tide (Q50) or the flood-of-record, whichever is greater without causing objectionable backwater, excessive flow velocities, or encroaching on through traffic lanes. Sufficient freeboard, the vertical clearance between the lowest structural member, and the water surface elevation of the design flood should be provided. A minimum freeboard of 2 feet is often assumed for preliminary bridge design. An evaluation should be performed to determine, if horizontal and vertical driftway requirements warrant a modified freeboard. The freeboard for controlled flow waterways, such as irrigation canals, shall be required by the regulatory agency having jurisdiction.

- The final design should be able to convey the base flood, Q100.
- The base flood (Q100) or overtopping flood, whichever is greater shall be used to evaluate the costs, risks and impacts associated with encroachments on the 100-year base flood plain.
- The minimum design flood for foundation analysis should be the base flood (Q100). Bridges with scourable beds should withstand the effects of the base flood (Q100) without failure. The top of pier footing should be placed at, or below the calculated total scour condition including anticipated lateral channel migration. Pile extensions and pile shafts should have sufficient embedment depth for the potential scour conditions.
- Consideration should be given to the long-term effects as to the bridge waterway adequacy. This is part of data to be collected and retained for FHWA's use per CFR Section 650.311. Specifically, this data is included in the Sufficiency Rating (see the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*, published by FHWA), which is used in the HBRR Program, as a basis for establishing eligibility and priority for replacement, and rehabilitation of bridges (CFR 650.409).

CULVERTS:

There are two primary design frequencies that should be considered in the design of drainage culverts. A culvert should convey:

- The ten percent (10%) probability flood or tide (Q10) without causing the headwater elevation to rise above the inlet top of culvert.
- The one percent (1%) probability flood (Q100) without damage to the facility or adjacent property.

OPEN CHANNELS/CONDUITS:

- Open channels/conduits should be designed according to the above bridge criteria with appropriate freeboard.

ROADSIDE DRAINAGE:

- The spacing of roadway inlets for pavement drainage vary with the desirable limits or water spread, which in turn depend on the type of facility, design storm frequency, traffic volume, design speed, and any local requirements. The recommended limits for water spread on various types of roadway facilities are provided in Chapters 800 to 890 of the *Caltrans Highway Design Manual*.

Additional information on the design of culverts including: hydrologic and hydraulic design considerations; height of fill limitations; protection from abrasion and corrosion; as well as, other economic, construction and maintenance considerations are included in the *Caltrans Highway Design Manual*.

Flood Plain Encroachments

Proposed actions which encroach on a base flood plain or support incompatible flood plain development must be evaluated in a location Hydraulic Study to assess impacts on natural and beneficial flood plain values in accordance with 23 CFR 650A. The location hydraulic study must provide the following information:

- A brief description of the project hydrology
- A description of the types of traffic
- Emergency access data, availability of detours, etc.
- Comments on constraints which influence selection of available alternatives
- The location of property at risk
- An estimate of potential damage to property at risk
- A discussion of the environmental impacts

A summary of the location hydraulic study shall be included in the environmental document.When there is a significant encroachment within the base flood plain, a finding that the project is the only practical alternative (the local agency must assure the opportunity for early public involvement) shall be included in the final environmental "NEPA" document and concurred with by the FHWA.

Encroachments within regulatory floodways are generally not permitted. Local agencies should consult the appropriate federal, state or local regulatory agency for more information.

The design selected for the encroachment must be supported by an analysis of design alternatives, with consideration given to capital costs, risks, and other economic, engineering, social, and environmental concerns. Refer to 23 CFR 650.117 for the required content of the design studies. Upon completion of the environmental process, a hydraulic design study is required as part of the final design process.

The above technical engineering reports shall be prepared by a registered Civil Engineer in the State of California. The reports shall bear the registration seal, signature, license number and registration certificate expiration date of the California Registered Professional Engineer responsible for preparing the report.

When there is a potential for extensive disruption of essential services or incurring losses due to implementation of the proposed action; a comprehensive risk and cost analysis may be advisable during the final design stage. If a risk/cost analysis is anticipated, it is recommended that the results of preliminary studies be reviewed with the FHWA to confirm the need for the analysis.

For additional information on analysis of encroachments onto a flood plain, refer to Chapter 17, "Flood Plains,"of the *Standard Environmental Reference* (SER) and at this website: http://www.dot.ca.gov/ser/vol1/vol1.htm.

Level of Evaluations

It is the policy of Caltrans and FHWA that the level of evaluation comply with federal and state mandated procedures and be commensurate with the risks and environmental impacts involved. An initial level of evaluation based on preliminary project data, may be established during the Preliminary Environmental Study (PES) (see Chapter 6, *Environmental Procedures*, of the LAPM and at this website:

http://www.dot.ca.gov/hq/LocalPrograms/lam/lapm.htm).

Refer to Exhibit 11-D entitled *Preliminary Hydrologic/Hydraulic Summary*, of this chapter for the information to be provided by a local agency "prior to or at" the early coordination meeting. The actual level of evaluation may change due to unforeseen conditions or impacts revealed during the environmental review and detailed design stage of project development. A less comprehensive evaluation is appropriate for encroachments at locations where the risk of property damage or damage to the facility is small. A decision to raise or lower the level of evaluation should be made in consultation with the FHWA.

A rehabilitation project including widening represents a significant financial investment and must be evaluated for compliance with current hydraulic design criteria for the project location. Any deviations must be justified and documented in the project files.

A comprehensive list of items to be considered for inclusion in drainage studies and reports is included in Exhibit 11-E, "Checklist for Drainage Studies and Reports," in this chapter. This exhibit also includes an excellent list of references for background information.

Scour Evaluations

A scour evaluation should be conducted for all bridges over water. The scour evaluation should include consideration of long-term aggradation/degradation, contraction scour, local scour, and lateral migration. The details of the scour evaluation shall be commensurate with the risk associated with the structure.

The FHWA has developed Hydraulic Engineering Circular (HEC) "#18 Evaluating Scour at Bridges" to aid in proper development of the necessary scour evaluations. Calculations similar to those in HEC #18 may be used for evaluating scour at bridges. The scour evaluation should be done by an interdisciplinary team consisting of hydraulic, geotechnical and structural engineers. Bridges with scourable beds should withstand the effects of the Q_{100} flood without failure. HEC #20 entitled "Stream Stability at Highway Crossings" is another resource for evaluating stream stability at design locations. For existing bridges that are susceptible to scour, refer to HEC "#23, Bridge Scour and Stream Instability Countermeasure," for suggested preventative measures.

Consideration should be given to the effect of aggregate mining contributing to scour at bridge foundations. Mining without proper monitoring and regulation could jeopardize federal funding for a damaged structure, if a local agency is aware of severe degradation due to mining and does nothing to mitigate the loss of material.

General Design Considerations for Bridges and Culverts

The effect on all permanent flood control structures, either under construction or in place shall be considered in determining the effects of the design flood. Runoff estimates should be based on the land development expected in the watershed twenty years hence.

The effect of bedload, drift, ice, upstream and downstream mining operation, etc., should be considered for all structures, and where appropriate, adequate armor, debris racks, clearance, etc., should be provided.

Typically, proposed construction which is capable of impounding water to the extent that it meets the legal definition of a dam must be approved by the Department of Water Resources (DWR), Division of Safety of Dams. The legal definition of a dam is given in Sections 6002 and 6003 of the *State Water Code*. Generally, any facility 25 feet or more in height, or impound capacity of 50 acre-feet or more, is considered a dam. However, any facility 6 feet or less in height, or storage capacity 15 acre-feet or less, shall not be considered a dam. Additionally, Section 6004 of the *State Water Code* states "*... and no road or highway fill or structure ... shall be considered a dam.*" Therefore, except for large retention or detention facilities, there is rarely a need for involvement by the DWR.

Although most designs will be exempt from DWR approval, caution should always be exercised in the design of high fills that could impound large volumes of water. Even partial plugging of a cross drain could lead to high pressures on the upstream side of the fill, creating seepage throughout the fill and/or an increased potential for piping.

Documentation

Whenever a waterway is involved, hydraulic studies must be performed and documented. The location hydraulic studies, which determine the selection of design alternatives, evaluate favorable or adverse effects of the facility on the stream environment; analyze other economic, engineering, and environmental concerns and detailed design studies; must be documented and retained in the local agency's permanent project design files. Upon request, these studies must be made available to the public, Caltrans, or FHWA. The documentation of the FHWA finding regarding the floodplain also must be retained in the files.

The following hydrologic data shall be shown on the contract plans:

Drainage Area_____ (acre)

	Design Flood	Base Flood	Overtopping Flood	Flood of Record
Frequency (years)	_____	_____	_____	_____
Discharge (cubic feet/second)	_____	_____	_____	_____
Water Surface Elevation at Bridge (feet)	_____	_____	_____	_____

Standard Plans

The following standard plans are acceptable for use on all local federal-aid projects not located on the SHS:

- The current edition of *Caltrans Standard Plans*
- The current edition of the *Standard Plans for Public Works Construction* (commonly referred to as "*the Green Book*"), developed and promulgated by the American Public Works Association, Southern California Chapter, and the Associated General Contractors of California, Southern California Districts

For locally sponsored projects on the SHS, the *Caltrans Standard Plans* must be used.

Standard Specifications

The following standard specifications are acceptable for use on all local federal-aid projects not located on the SHS:

- The current edition of *Caltrans Standard Specifications*
- The current edition of the *Standard Specifications for Public Works Construction* (commonly referred to as the "*Green Book*"), written and promulgated by the American Public Works Association, Southern California Chapter, and the Associated General Contractors of California, Southern California Districts
- Local standard specifications may be used for projects on the NHS, provided they have been reviewed and approved for such use by Caltrans.

For locally sponsored projects on the SHS, Caltrans Standard Plans and Specifications must be used.

11.3 Locally Developed Design Standards

Plans and specifications for federal-aid highway projects shall provide for a facility that adequately meets the existing and probable future traffic conditions in a manner conducive to safety, durability, and economy of maintenance. Section 109, *Standards*, of Title 23 of the U.S. Code also requires that projects shall be designed and constructed to conform to the particular needs of each locality.

Since statewide standards do not always meet the particular needs of each locality, local design standards that meet the following requirements are allowed on local federal-aid projects off the SHS.

Local Geometric Standards

Local geometric design standards that have been developed for use on locally funded new and reconstruction, or 3R projects, may be used on federal-aid projects off the NHS if:

- The standards have been approved by the County Board of Supervisors or the City Council,

- The standards must be signed by the City/County Public Works Director if he/she is a California registered Civil Engineer. If not, they may be signed by the City/County Engineer if registered. If the City/County Engineer is not registered, the delegation can be made to the highest level engineer in the agency who is registered. Locally adopted design standards may be signed by a consultant on retainer as City/County Engineer if such individual is registered and is responsible directly to the Public Works Director or City/County Manager, and
- Locally adopted design standards are reviewed for possible updating whenever the applicable AASHTO standards are updated.

Local Pavement Structural Section

Pavement structural section design methods or standards developed by a local agency for their own locally funded projects may be used for all local federal-aid projects off the NHS.

11.4 Design Exceptions

Occasionally, project conditions may warrant an exception to certain accepted standards or procedures. Such conditions might include: extreme difficultys or high cost of obtaining right of way; cost of construction; or the mitigation of environmental impacts.

Although all deviations from accepted standards and procedures must be justified and documented in some manner and retained in the project files; not all design exceptions must adhere to the formal design exception procedures as described below.

Standards For Which Deviations Are Permitted

Deviations from accepted standards are permitted as follows:

Geometric Criteria - The FHWA has determined that deviation from the following geometric control criteria for highways and bridges require formal approval:

- Design speed
- Cross slope
- Lane and shoulder width
- Superelevation
- Horizontal and vertical alignment
- Horizontal and vertical clearance
- Stopping sight distance
- Bridge width
- Grades

Any deviation from standards related to the above geometric criteria require that the local agency comply with the design exception approval procedures described below.

It is important to note that design exceptions that would result in the construction of a federally funded new bridge that would result in a Sufficiency Rating (SR) of less than 80 are not allowed. The controlling criteria for bridge width, vertical and horizontal over and under bridge clearances, and approach roadway alignment are among the factors that are rated during each biennial bridge inspection. Explanation of the rating factors can be found in the publication entitled *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges.*

Safety - Deviations from the above geometric control criteria related to safety must be handled in accordance with the procedures outlined below. Deviations from the criteria contained in the other safety-related publications referenced in Section 11.2 do not require special handling.

Pavement Structural Section - Deviations from the pavement structural section design criteria referenced herein must be justified and documented in some manner, but do not require approval in accordance with the design exception approval procedures described below.

Drainage - The hydrologic and hydraulic criteria contained herein is for guidance only. Deviations should be justified and documented, but do not require approval in accordance with the design exception approval procedures described below.

Bridge Railings - Deviations from the nonstructurally related design criteria referenced herein do not require approval in accordance with the design exception approval procedures described below. Bridge rail on NHS projects let after August 16, 1998, must meet crash test requirements of NCHRP 350.

Bikeways - Deviations from the "Mandatory Standards," as defined and indicated in the *Caltrans Highway Design Manual*, require approval in accordance with the design exception approval procedures described below.

Pedestrian Facilities - Deviations from the state pedestrian standards shall be documented in a form of a memo and retained in the project files. This memo shall discuss the justification and reasoning for not meeting the applicable standards. Deviation from federal pedestrian standards shall be documented in accordance with the federal *ADA Standards for Accessible Guidelines for Buildings and Facilities*.

Standards For Which Deviations Are Not Permitted

Bridge Structural Capacity - Deviations from the criteria contained herein for the structural capacity of bridges and other structures are not allowed. Deviations from bridge design details in the various Caltrans bridge design manuals and publications referenced herein are permitted as long as they do not impact structural capacity.

Signs and Markings - Deviations from the "Mandatory Standards" for signs and markings as defined and indicated in the *Manual on Uniform Traffic Control Devices* (MUTCD) and the *MUTCD California Supplement* are not allowed, unless a proposal to experiment with non-standard devices is submitted to the California Traffic Control Devices Committee and approved for experimental use.

Design Exception Approval Procedures

Local Projects on the State Highway System

Local projects on the SHS must follow the design exception approval procedures outlined in the Caltrans *Project Development Procedures Manual*. Refer to this website at: http://www.dot.ca.gov/hq/oppd/pdpm/pdpmn.htm

Local Projects not on the State Highway System

The following design exception approval procedures are to be followed.

The FHWA has delegated Caltrans approval authority for design exceptions on local projects not on the SHS. However, since local agencies are in a better position to assess applicability to any given situation on local roads; design exception approval authority (for those standards from which deviations are permitted) is now delegated to the City and County Public Works Directors. Public Works Directors may delegate this approval authority within their local agency, if the Public Works Director is not a registered civil engineer in the State of California, or if the local agency has a large engineering staff with multiple layers of responsibility. The person with approval authority must be a registered civil engineer in the State of California. Approval of design exceptions on local federal-aid projects shall be signed by the Public Works Director or the person to whom approval authority has been delegated.

The approval authority for design exceptions may be delegated to a private consulting firm that is on retainer as City or County Engineer.

To facilitate process reviews (see Chapter 19, *Process Reviews*, of the LAPM), local agencies are required to keep copies of design exceptions prepared for their projects in their project files. If any local agency fails to complete and retain the completed and approved project design exception; their delegation to approve future design exceptions may be rescinded.

Design Exception Fact Sheet

The standard *Design Exception Fact Sheet* (Exhibit 11-F in this chapter) must contain the following information:

- Existing conditions
- Proposed work and nonstandard features
- Standard for which the exception is required
- Accidents - if applicable
- Design year traffic volumes - if applicable
- Added cost to make standard
- Description of any additional work to enhance safety
- Reason for requesting exception
- Reviews

The *Design Exception fact Sheet* must be signed, stamped with engineer's seal, and approved by Director of Public Works, or the person whom approval authority has been delegated.

Tracking of Design Exceptions

A tracking system for design exceptions should be implemented by local agencies to retrieve project information quickly and accurately. The data should include:

- Project description.
- Project location
- Nonstandard features approved
- Indication if future commitments have been made
- Brief description of commitments to upgrade the project to design standards at a future date

11.5 References

1. American Association of State Highway and Transportation Officials (AASHTO)

- *A Policy on Geometric Design of Highways and Streets, current edition (2004)*
- *Guide Specifications for Bridge Railings, current edition*
- *Roadside Design Guide, current edition (2002)*
- *Standard Specifications for Highway Bridges, current edition*

2. California Department of Transportation (Caltrans)

- *Bank and Shore Protection, 1970*
- *Bridge Design Aids, current edition*
- *Bridge Design Details, current edition*
- *Bridge Design Details, current edition*
- *Bridge Design Practice Manual, current edition*
- *Bridge Design Specifications, current edition*
- *Bridge Memo to Designers, current edition*
- *Vehicle Crash Tests of Steel Bridge Barrier Rail Systems for Use on Secondary Highways, Final Report # FHWA/CA/TL-93/01,* Division of New Technology, Materials and Research
- *Flexible Pavement Structural Section Design Manual*
- *Flexible Pavement Structural Section Guide for California Cities and Counties*
- *Highway Design Manual*

  Chapter 80 - Application of Design Standards
  Chapter 200 - Geometric Design and Structure Standards
  Chapter 600 - Design of the Pavement Structural Section
  Chapters 800 to 890 - Highway Drainage Design
  Chapter 1000 - Bikeway Planning and Design
- *Local Assistance Procedures Manual* (LAPM)
- MUTCD *(Manual on Uniform Traffic Control Devices) California Supplement*
- *Standard Environmental Reference (SER)*
- *Project Development Procedures Manual, current edition*
- *Standard Plans*
- *Standard Specifications*
- *Design Information Bulletin* (DIB*) 79-02*
- Minimum Standards for Geometric Design of federal-Aid Resurfacing, Restoration, and Rehabilitation Projects on Local Streets and Roads (1988).

3. FEDERAL OR FEDERAL HIGHWAY ADMINISTRATION (FHWA)

- *FHWA Internet Home Page: http://www.fhwa.dot.gov*
- *23 USC Standards*
- *Designing Sidewalks and Trails for Access (Part 2), FHWA-EP-01 027*
- *Federal-Aid Policy Guide, Subchapter G, Engineering and Traffic Operations, Part 625 - Design Standards for Highways*
- *28 CFR Part 36 Nondiscrimination on Basis of Disabilities by Public Accommodations and in Commercial Facilities, Appendix A Standards For Accessible Design*
- *28 CFR Part 35 Nondiscrimination on the Basis of Disability in State and Local Government Services*
- *41 CFR Part 101*
- *23 CFR Part 650 Bridges, Structures and Hydraulics*
- Hydraulic Engineering Circulars
  - *Design of Riprap Revetment* - Hydraulic Engineering Circular #11,
  - *Evaluating Scour at Bridges* - Hydraulic Engineering Circular #18,
  - *Stream Stability at Highway Crossings* - Hydraulic Engineering Circular #20,
- *Manual on Uniform Traffic Control Devices (MUTCD), current edition*
- *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridge, Report No. FHWA-ED-89-044*
- *FHWA Contract Administration Core Curriculum, Guide* 2001

4. OTHER

- *Designing Safer Roads - Practices for Resurfacing, Restoration and Rehabilitation, Special Report 214, Transportation Research Board*
- *Roadside Safety, Transportation Research Record 1065, Transportation Research Board*
- *Recommended Procedures for the Safety Performance Evaluation of Highway Appurtenances, National Cooperative Highway Research Program Report 230*
- *Multiple-Service-Level Highway Bridge Railing Selection Procedures, National Cooperative Highway Research Program Report 239*
- *Standard Plans for Public Works Construction,* developed and promulgated by the American Public Works Association, Southern California Chapter, and the Associated General Contractors of California, Southern California Districts
- *Standard Specifications for Public Works Construction,* developed and promulgated by the American Public Works Association, Southern California Chapter, and the Associated General Contractors of California, Southern California Districts
- *Recommended Procedures for the Safety Performance Evaluation of Highway Features, Report 350*

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EXHIBIT 11-A GEOMETRIC DESIGN STANDARDS FOR LOCAL 3R PROJECTS

GEOMETRIC DESIGN STANDARDS FOR LOCAL 3R PROJECTS

Table 11-1: Lane and Shoulder Widths Arterial Roads and Streets

Design Year Volume (ADT)	Design Speed (mph)	Lane Width (feet)	Shoulder Width [a] (feet)	Total Roadway Width (feet)
Low Volumes:				
1 - 750 ADT	All	10	2	24
High Volumes:				
751 - 2,000 ADT	All	12	2 [b]	28 [c]
Over 2,000 ADT	All	12	6 [b]	36 [c]

[a] All shoulders on rural and urban arterials to be paved.

[b] Reduce by 1 foot for highways on mountainous terrain.

[c] Reduce by 2 feet for highways on mountainous terrain.

TABLE 11-2: LANE AND SHOULDER WIDTHS COLLECTOR ROADS AND STREETS

Design Year Volume (ADT)	Design Speed [a] (mph)	Lane Width (feet)	Shoulder Width [b] (feet)	Total Roadway Width (feet)
Low Volumes:				
1 - 750 ADT	All	10	2	24
High Volumes:				
751 - 2,000 ADT	Under 50	10	2 [c]	24 [d]
	50 and over	12	2 [c]	28 [d]
Over 2,000 ADT	All	12	4 [c]	32 [d]

[a] Highway segments should be classified as “under 50” only if most vehicles have an average speed of less than 50 mph over the length of the segment

[b] All shoulders on collector roads and streets to be paved.

[c] Reduce by 1 foot for highways on mountainous terrain.

[d] Reduce by 2 feet for highways on mountainous terrain.

TABLE 11-3: LANE AND SHOULDER WIDTHS LOCAL ROADS AND STREETS

Design Year Volume (ADT)	Design Speed [a] (mph)	Lane Width (feet)	Shoulder Width (feet)	Total Roadway Width (feet)
Low Volumes:				
1 - 750 ADT	All	10	2	24
High Volumes:				
751 - 2,000 ADT	Under 50	10	2 [b]	24 [c]
	50 and over	12	2 [b]	28 [c]
Over 2,000 ADT	All	12	4 [b]	32 [c]

[a] Highway segments should be classified as "under 50" only if most vehicles have an average speed of less than 50 mph over the length of the segment

[b] Reduce by 1 foot for highways on mountainous terrain.

[c] Reduce by 2 feet for highways on mountainous terrain.

TABLE 11-4: LANE WIDTHS URBAN ROADS AND STREETS

TYPE OF LANE	**MINIMUM WIDTH(FEET)**
Curb Lane	
No Parking Anytime [a]	**11**
Part-time Use (peak hour/high volume/low speed)	**9**
With Parking	**19**
Interior Lane	**10**
Lane Adjacent to Median	
Raised Curb	**10**
Painted Median	**10**
Left-Turn Lane	
One-Way (one lane only)	**10**
Two-Way (continuous)	**10**
Bicycle Lane (Within Roadway)	
One-Way	**4**
Bicycle Lane and Parking (One-Way)	**12**

[a] A 1 foot curb lane, with up to 2 feet wide gutter, may be used at intersections.

TABLE 11-5: BRIDGES ON ARTERIAL ROADS AND STREETS

Design Year Volume (ADT)	Minimum Usable Bridge Width [a]
1 - 750	Width of approach lanes [b]
751 - 2,000	Width of approach lanes plus 2 feet each side
2,001 - 6,000	Width of approach lanes plus 4 feet each side
Over 6,000	Width of approach lanes plus 8 feet each side

[a] If lane widening is planned as part of a 3R project, the usable bridge width should be compared with the planned width of the approaches after they are widened.

[b] Minimum usable bridge width to be 24 feet.

TABLE 11-6: BRIDGES ON COLLECTOR ROADS AND STREETS

Design Year Volume (ADT)	Minimum Usable Bridge Width [a]
1 - 750	Width of approach lanes [b]
751 - 2,000	Width of approach lanes plus 2 feet each side
2,001 - 6,000	Width of approach lanes plus 4 feet each side
Over 6,000	Width of approach lanes plus 8 feet each side

[a] If lane widening is planned as part of a 3R project, the usable bridge width should be compared with the planned width of the approaches after they are widened.

[b] Minimum usable bridge width to be 24 feet.

TABLE 11-7: BRIDGES ON LOCAL ROADS AND STREETS

Design Year Volume (ADT)	Minimum Usable Bridge Width [a]
1 - 750	Width of approach lanes
751 - 2,000	Width of approach lanes plus 2 feet each side
Over 2,000	Width of approach lanes plus 4 feet each side

[a] If lane widening is planned as part of a 3R project, the usable bridge width should be compared with the planned width of the approaches after they are widened.

TABLE 11-8: HORIZONTAL AND VERTICAL ALIGNMENT ARTERIAL ROADS AND STREETS

Design Speed (mph)	Minimum Stopping Sight Distance (feet)	Minimum Radius of Horizontal Curve (feet) Super-Elevation 10% (a)	Super-Elevation 8% (b)	Maximum Grade (%) Rural Level	Rolling	Mountains	Urban Level	Rolling	Mountains
30	200	230	250	...	...	...	8	9	11
40	275	430	470	...	...	...	7	8	10
50	400	695	765	4	5	7	6	7	9
60	525	1,090	1,205	3	4	6	5	6	8

[a] Generally, superelevation should not exceed 10 percent.
[b] Superelevation should not exceed 8 percent where snow and ice conditions prevail.

TABLE 11-9: HORIZONTAL AND VERTICAL ALIGNMENT COLLECTOR ROADS AND STREETS

Design Speed (mph)	Minimum Stopping Sight Distance (feet)	Minimum Radius of Horizontal Curve (feet) Super-elevation 10% (a)	Super-elevation 8% (b)	Maximum Grade (%) Rural Level	Rolling	Mountains	Urban Level	Rolling	Mountains
20	125	100	105	7	10	12	9	12	14
30	200	230	250	7	9	10	9	11	12
40	275	430	470	7	8	10	9	10	12
50	400	695	765	6	7	9	7	8	10
60	525	1,090	1,205	5	6	8	6	7	9

[a] Generally, superelevation should not exceed 10 percent.
[b] Superelevation should not exceed 8 percent where snow and ice conditions prevail.

TABLE 11-10: HORIZONTAL AND VERTICAL ALIGNMENT LOCAL ROADS AND STREETS

Design Speed (mph)	Minimum Stopping Sight Distance (feet)	Minimum Radius of Horizontal Curve (feet)		Maximum Grade (%)		
		Super-Elevation 10% (a)	Super-elevation 8% (b)	Rural		
				Level	Rolling	Mountains
20	125	100	105	8	11	16
30	200	230	250	7	10	14
40	275	430	470	7	9	12
50	400	695	765	6	8	10
60	525	1,090	1,205	5	6	...

[a] Generally, superelevation should not exceed 10 percent.
[b] Superelevation should not exceed 8 percent where snow and ice conditions prevail.

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EXHIBIT 11-C FOUNDATION INVESTIGATIONS FOR DESIGN

FOUNDATION INVESTIGATION FOR DESIGN

A foundation investigation and report is required for all proposed structure sites. The study and report shall be made by a California licensed Engineering Geologist or Civil Engineer, who specializes in foundations. The report shall, at a minimum, address all "applicable" topics shown in the following Caltrans checklist.

Specific attention is directed to appropriate sections of the *Caltrans Bridge Design Specifications*, Section 4- "FOUNDATIONS." All driven pile support recommendations shall consider the use of Caltrans Standard Class 45 or Class 70 piles using design loads of 45 and 70 tons, respectively.

A Log of Test Borings sheet shall be drafted and included as part of the foundation report, and as part of the structure plans.

CHECKLIST FOR STRUCTURE FOUNDATION STUDIES AND REPORTS

LOG OF TEST BORINGS SHEET

A log of Test Borings sheet (similar to Caltrans' sheet) shall be included as part of the Foundation Report. Show the location of each boring or test pit in plan view. Logs of all borings shall be shown in an elevation or profile view on the sheet. Information which should be shown on plots of test borings is as follows:

1. Diameter, type, and date of boring.
2. Location of borings with respect to stationing along survey lines for the proposed project**.**
3. Elevation of the top of each boring, etc.
4. Description of samplers, sampling methods, and in-situ tests.
5. Test results including Standard Penetration Test. Results of the Standard Penetration Test (ASTM D-1586-84) shall be presented so that quick correlation with the Caltrans data base may be made.
6. Soil or rock descriptions and elevations of strata.
7. Groundwater elevation and date of measurement should be shown adjacent to the boring or test pit where taken.
8. Location, description, and elevation or the benchmark used for determining the top-of-hole elevations shown on the Log of Test Borings.
9. Name and position or title of person conducting the field study.
10. Name and position or title of the registered Engineering Geologist or Civil Engineer approving the "Log of Test Boring Sheet."

WRITTEN REPORT

A written report shall be prepared, which shall contain an interpretation and analysis of the foundation conditions based upon all available sources of data. Data may come form new or previous exploration programs, laboratory testing, and nearby construction experience, performance of nearby structures, etc. A short description of site topography geology should be included. Emphasis should be placed on slope stability of cuts and excavations, unusual groundwater conditions, springs, etc. All sources of information should be cited. The materials and conditions, which may be encountered during construction, shall be discussed. Problems involving design and construction should be anticipated and recommendations made for their solution. The recommendations shall be brief, concise, and definite. Reasons for recommendations and their supporting data shall always be included. Methods used for calculating pile capacities and soil-bearing capacities should be mentioned for ease of review. Extraneous data, which are of no use to the designer or Resident Engineer, should be omitted.

The written report shall be include, but not limited to, information and recommendations regarding applicable items in the following lists:

1. TYPING OF FOUNDATION

A. Pile Support (Driven or Cast-In-Drilled-Hole)

1. Method of support (skin friction and/or end bearing) in rock or soil or both.
2. Suitable pile type(s)-reasons for choice and/or exclusion or types. When appropriate, Caltrans' standard piles should be used.
3. Pile tip elevation
   a. Specified (use of "indicator piles" is not acceptable.)
   b. Probable
   c. Need for pre-drilling or jetting
4. Pile Design Load and Ultimate Capacity in compression and tension. Specify the Safety Factor.
5. Reduction of pile capacity due to negative skin friction.
6. Requirement for load test. Specify which portion of the structures' foundation will be controlled by the test.
7. Effects on adjacent existing structures.
8. Corrosion effects of various soils and waters, and possibility of galvanic reaction from stray currents.
9. Scour depth (elevation) and method of determination.

B. Footing Support

1. Elevation of bottom footing.
2. Allowable and ultimate footing pressure (include Safety Factor). Approximate settlement at uniformly distributed allowable load.
3. Brief Description of materials on which the footing is to be placed.
4. Scour depth (elevation).

C. Drilled Shafts/Pier Columns (Mined Shafts)

1. Geologic description of foundation materials
2. Diameter (or dimensions)
3. Design Load, ultimate loads, and safety factor
4. a. Top of shaft elevation
   b. Bottom of shaft elevation
   c. Minimum shaft length into load carrying stratum
   d. Estimate of shaft wall stability and possible shoring requirements
5. Soil or rock weight and strength parameters for determining end bearing capacity, lateral load capacity, and point of shaft/column fixity.

11. APPROACH FILL REQUIREMENTS

1. Predicted amount of settlement and time delay required prior to beginning foundation construction. Predicted post construction settlement. Possibility of negative friction on pile foundations.

2. Special Requirement:
   a. Controlled rates of embankment placement.
   b. Fill height limit on untreated foundation.
   c. Stripping of unsuitable foundation materials.
   d. Use of lightweight fills to reduce amount of settlement.
   e. Use of surcharge, wick drains, or other methods to shorten the required time delay period.
   f. Specify embankment side slopes.
   g. Unusual compaction requirements (i.e. 95% relative compaction) where abutments on spread footings are used.

111. CONSTRUCTION CONSIDERATIONS

1. Water table-seasonal or long term fluctuations, data for possible control in excavations (i.e. pumping, well points, trim seals, amounts of groundwater, etc.).
2. Adjacent structures-protection against damage form excavations, pile driving , etc.
3. Pile driving-difficulties, clearance, overhead or underground utilities, other unusual conditions, etc.
4. Excavation-control of earth slopes including shoring, sheet piles, bracing, and safety requirements.

IV SEISMIC DATA

The foundation report should contain the following information, so that an evaluation of seismicity can be made per the Caltrans Bridge Design Specifications.

1. Maximum credible rock acceleration (from CDMG MS-45*)
2. Magnitude of the maximum credible event.

3. Name of the causative fault and distance from the site.
4. Depth to rock or rock-like material (Vs > 2500 ft/s). Provide supporting evidence for depth (i.e. boring log or geologic reference)
5. Liquefaction potential.
6. Need for "seismic approach slab.

V. REVIEW OF FINAL STRUCTURE PLANS.

The foundation consultant should review the structure plans to ensure that the foundation recommendations have been followed, and provide revised recommendations, if required by design changes, etc.

***MUALCHIN, LALLIANA (1987) CALIFORNIA DIVISION OF MINES AND GEOLOGY MAP SHEET 45, ROCK ACCELERATION FROM MAXIMUM CREDIBLE EARTHQUAKES IN CALIFORNIA.**

EXHIBIT 11-D PRELIMINARY HYDROLOGIC/HYDRAULIC REVIEW SUMMARY

PRELIMINARY HYDROLOGIC/HYDRAULIC REVIEW SUMMARY

Bridge Name (facility crossed) _____

_____

State Bridge No. _____ **Road Name** _____

Hydrologic and Hydraulic Data

1. Size of drainage basin _____
2. Design flows and water surface elevations (USGS)
   a. Q_{10} _____ elevation _____ (culverts only)
   b. Q_{50} _____ elevation _____
   c. Q_{100} _____ elevation _____
3. High water marks _____ (Elevation/Year)
4. Structure opening size Date Constructed
   a. Existing _____ _____
   b. Upstream _____ _____
   c. Downstream _____ _____
5. Description of property risks _____
6. Summary of upstream development _____
7. Importance of structure _____
8. Description of risks to life _____
9. Effects of facility on stream environment _____
10. Are there any channel restrictions or controlled flow?
11. Has this basin been studied before? Date of study? Is the Study recognized by Caltrans?
12. Is there a potential debris problem? (describe)
13. Are there any mining operations within 3000 feet upstream and/downstream? _____

Remarks: _____

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EXHIBIT 11-E CHECKLIST FOR DRAINAGE STUDIES AND REPORTS

CHECKLIST FOR DRAINAGE STUDIES AND REPORTS

This is a checklist of items to be considered for inclusion in hydraulic studies and reports. For definition of terms see section entitled "*Definitions*" of this chapter.

1. PRELIMINARY

a. Review of basic guidelines

1. A floodplain cannot be altered in any way until it has been shown that such alteration will pass the base flood without significant damage to either the floodplain or surrounding property. This requirement is often referred to as "conveyance of the base flood." (Conveyance may be through structures, over the roadway, through escapements, through overflow channels, or any combination of the above.)
2. Approval for actions within a floodplain cannot be given until various options of alignments, grade, and waterway area have been appraised.
3. No bridge abutments or embankment shall encroach on a regulatory floodway.

b. Collect appropriate and readily available published data such as:

1. USGS quadrangle maps
2. NFIP maps - Floodplain maps may be obtained from the National Flood Insurance Program (NFlP), or the Local Caltrans District office
3. Aerial photos - Check with Caltrans
4. Runoff records - USGS water supply papers
5. Rainfall records- Various sources
6. Prior hydrology reports including photos and plans

c. Coordinate with other agencies

1. Determine whether permits are required.
2. Determine how the area is zoned.
3. Investigate possibility of cooperative projects.
4. Determine whether there exist or proposed water resource projects that will influence the design, and summarize details (Watershed area, storage capacity, etc., when pertinent).
5. Determine whether there is ongoing or proposed clearing, construction, land leveling, land development, aggregate mining, etc., that would affect flow in or the stability at the stream.

d. Floodplain Encroachments

1. Executive order 11988 establishes the federal policy on floodplain management. This policy has been implemented by 23 CFR, Part 650A (23 CFR 650A).
2. CFR 650A requires all encroachments and all actions, which affect an area, subject to flooding by flood or tide having a one-percent chance of being exceeded in any given year, to comply with a floodplain management policy. Repairs made to existing facilities with emergency funds (see *Local Programs Manual* which discusses Emergency Relief) during or immediately following a disaster are exempt from this policy.

e. The hydrology and hydraulics report shall:

1. Only be as comprehensive as the conditions warrant. Calculations with short comments are sufficient for a culvert in a well-defined drainage environment. A complete comprehensive document is required for a major stream crossing in an ecological setting.
2. Generally be structured along these guidelines with:
   a. Background data and estimates of future flood.
   b. Calculations to determine velocities, water surface elevations, backwater and scour depth (the lead agency should provide a disk with the data used to run HEC-2 or WSPRO. If a program other than these is used, that program should be provided on a disc along with the data used).
   c. Illustrative photos.
   d. Comments on selection of design flood, conveyance of 100-year flood, channel change, effect on stream stability, and provisions for fish passage.

f. Suggested desirable hydraulic features

1. The following features should be considered in the design of a bridge or culvert:
   a. Use of warped wingwalls
   b. No open vents
   c. No piers in main channel
   d. Use of energy dissipaters
   e. Extending pier walls to edge of deck
   f. No piers in navigable channel

2. **FIELD RECONNAISSANCE** -- Should be made by the engineer making the hydrologic and hydraulic analysis

a. Channel stability

1. Estimate the erodability of streambed material.
2. Document bends, meanders, and any eroded areas.
3. Is the existing protection providing adequate erosion control, and if so, is it fragile?
4. Are there signs of aggradations or degradation? Other scour considerations?
5. Are there any upstream or downstream mining operations?

b. Potential problems

1. Consideration of the value of the property that would be damaged by the base flood or overtopping flood.
2. Size and amount of drift.
3. Ice, snow
4. Banks that would erode if flow is accelerated or redirected.
5. Check adequacy of abutment protection.

c. Environmental considerations

1. Beauty of area.
2. Fish habitat and wildlife cover.
3. Will local water supply or sanitation treatment facility be affected?
4. Is it within a park or recreation area?
5. See *Flood Plain Values* (see *Standard Environmental Reference (*SER), Chapter 17, " Flood Plains").

d. Alternative sites

1. Locate suitable alternative sites.
2. What are the advantages and disadvantages of the alternative sites?

e. Existing structures (including relief or overflow structures)

1. Locate existing nearby upstream or downstream structures with respect to proposed crossing or encroachment.
2. For each existing nearby structure note the type, number of spans, span lengths, vertical clearance, bent design or pier orientation.
3. For each nearby existing culvert estimate the size and number of cells.

f. Hydraulic data

1. Locate high water marks (give date and elevation).
2. Document both the flood history and source of information.
3. Document the damage to existing structures including abrasion, corrosion, wingwall failure, culvert entrance failure, pier settlement, or excessive aggradations or degradation.
4. Note the use of bank protection, drop structures, or any other sign of corrective work at existing structures.

g. Factors affecting water stage

1. Determine whether flood flow can escape to, or enter from, other watersheds during floods.
2. Determine whether any of the flow can bypass the site.
3. Determine whether backwater or tides affect the flow.
4. Determine what will control an overtopping flood.

3. ECONOMIC ANALYSIS

a. Make an economic analysis of all the reasonable alternatives based on construction cost, aesthetic cost, ecological cost, flood damage cost, loss of traffic service, etc.
b. Reject from further considerations those options that are not economically suitable alternatives.

4. FIELD SURVEY

a. Obtain topographic data for the suitable site alternatives. Extend limits to include overflows where practicable.
b. Locate, sketch, and record significant features such as buildings, levees, walls, fences, ditches, trees, boulders, etc., and where significant, record elevations.
c. Record water surface elevation, the elevation of the path of greatest depth as in a stream channel (thalweg elevation), and estimate velocity of flow.
e. Obtain channel cross-sections 500 and 1000 feet upstream and downstream where necessary.
f. Obtain data on boat traffic.
g. Take ample photographs at each site to illustrate the hydraulic and ecological features.
h. Take physical measurements of the existing structure and/or any other bridge or culvert with similar characteristics either upstream or downstream.
i. Where possible determine the foundation type (spread footings, piles) and foundation depth of all nearby structures.

5. SITE MAP CONSTRUCTION

a. Purpose: For use in estimating flood flow distribution; to locate cross section of stream; to show location of proposed encroachment and structures, alignment of piers, skew of crossing, stream controls, existing encroachments, existing highway structures, etc.

1. A specially prepared site map showing one foot and two feet contours, vegetation, and manmade improvements is normally required. In some cases cross-sections normal to flood flow are acceptable in lieu of the map. A minimum of 3 cross sections is required including one upstream, one at the crossing, and one downstream.

2. The site map should include the limits of the overtopping flood when practical.

3. Where there are two or more suitable alignments, a site map must be prepared for each.

6. HYDROLOGIC ANALYSIS

a. Hydrologic considerations

1. Determine drainage area above the proposed encroachment. Subdivide where runoff characteristics are or will be significantly different.

2. List available flood records at the encroachment and/or at nearby hydraulically similar

3. Calculate the flow at the proposed encroachment for the base flood and the design flood, if different. Include any other flow within the floodplain that affects the design of the project. The flood calculations should be made by using at least two widely used methods. Nearby stream gage data may be used, if the data is adequate to furnish the above.

4. Plot the flood frequency curve.

5. Plot the stage discharge curve.

b. Establish the existing flow conditions

1. Determine the distribution of flow and velocities for several discharges or stages in the natural channel for existing conditions. USCE, USGS, FEMA, etc., studies may be used as a general case.

2. Establish the maximum permissible upstream water surface for base flood.

c. Hydraulic design for bridges

1. Compute the water surface profile for various trial bridge lengths and discharges at each of the alternative sites. If alternate alignments are proposed, compute the water surface profile for various trial bridge lengths and discharges at each of the alternative sites.

(The Lead Agency should provide a disc with the data used to run the HEC-2 or WSPRO water surface profile computer programs. If a program other than HEC-2 or WSPRO is used that program should be provided on a disc along with the data used.)

(For the base flood, backwater caused by the encroachment together with that caused by all other man-made obstructions is limited to one foot above the water surface of the base flood.) Design must be in accordance with 23 CFR 650 Subpart A. The local agency must comply with FEMA's regulatory floodplain rules or they may lose their federal flood insurance.

2. Select alignment, grade, bridge type and size waterway openings, etc., on the basis of overall economic calculations and freeboard requirements (see section 10, *Design Standards*).

3. Check "conveyance" of base flood.
4. Calculate scour depth at piers. (Recommended reference HEC-18 *Evaluating Scour at Bridges*, FHWA
5. Design pertinent features such as riprap for bank protection, cross channel stabilizers for streambed control, energy dissipaters to reduce downstream velocities, spur dikes to equalize flow, etc. (Recommended references are HEC - 18 *Evaluating Scour at Bridges* and HEC - 20 *Stream Stability at Highway Structures*).

d. Hydraulic design for culverts (Recommended reference; Caltrans *Highway Design Manual*)

1. Determine allowable headwater elevation.
2. Compute and plot performance curves for trial culvert sizes at alternate alignments.
3. Evaluate erosion, abrasion, and corrosion potentials.
4. Select alignment, grade, and culvert design on the basis of overall economic calculations related to the design standards appropriate to the project.

.

e. Hydraulic design for longitudinal encroachments

1. Determine the effect of the proposed encroachment on water surface profile using various roadway design, alternatives, and the base flood.
2. Evaluate the effects on scour and deposition in the channel.
3. Select roadway design on the basis of overall economic calculations.
4. Design pertinent features such as bank protection, etc. (Recommended reference HEC-11 *Design of Riprap Revetment, FHWA and/or Bank and Shore Protection*, Caltrans)

7. CONTRACT PLANS

The following data shall be shown on the contract plans, and may be shown in tabular form. List the frequency, magnitude and pertinent water surface elevations for:

a. Minimum Design Flood
c. Base Flood
d. Overtopping Flood
e. Flood of Record, if available

The data used for design must be designated and if different from the above, the data must be shown on the plans.

HYDRAULIC REFERENCES

- *Guidelines for Hydraulic Considerations in Highway Planning and Location, Volume I, Highway Drainage Guidelines, AASHTO, 1999.*
- *Guidelines for Hydrology, Volume II, Highway Drainage Guidelines, AASHTO, 1999.*
- *Highway Hydrology*, HDS No.2, FHWA-SA-96-067, 1996.
- Flood-frequency analysis, such as those of U. S. Geological Survey or other water-resources agencies, for the region in which the structure is located.
- *Highways in the River Environment Hydraulic and Environmental Design Considerations, U.S. Department of Transportation, FHWA,* 1983
- *Stream Stability at Highway Structures, HEC-20, FHWA-0IP-90-014, 1991*
- Bradley, J. N., 1979, *Hydraulics of Bridge Waterways, Hydraulic Design Series No. l, Federal Highway Administration*, U.S. Government Printing Office, Washington, DC, 1978, 111 p.
- *Evaluating Scour at Bridges*, Second Edition, HEC-18, FHWA-IP-90-017, 1993.
- *Highway Research Board, 1979, Scour at Bridge Waterways, National Cooperative Highway Research Program Synthesis 5, Highway Research Board, National Academy of Sciences, 2101 Constitution Avenue, Washington, DC 20418.*
- *Hydraulic Design of Highway Culverts*, September 1985, Hydraulic Design Series No.--, Report No. FHWA-1P-85-15.
- *Circular Memorandum, G. M. Williams, July 21, 1966 Plans for Pipe Culvert Inlet and Outlet Structures, Federal Highway Administration.*
- *Guidelines for Hydraulic Design of Culverts, Volume IV, Highway Drainage Guidelines, AASHTO, 1999.*
- Searcy, J. K., *Design of Roadside Drainage Channels*, 1985, Federal Highway Administration, Hydraulic Design Series No. 4, U.S. Government Printing Office, Washington, DC.
- *Bridge Deck Drainage Systems*, HEC-21, FHWA-SA-92-010, 1993
- *Standard Environmental Reference* (SER), Chapter 17 " Flood Plains"
- *Design of Encroachments on Flood Plains Using Risk Analysis, HEC 17, FHWA-EPD-86-112, 1981*
- For information regarding flood plain delineation studies, write to: Department of Housing and Urban Development, Federal Insurance Administration, Assistant Administrator for Flood Insurance, 451 7th Street, SW, Washington, DC 20410
- *Design of Rip rap Revetment, HEC-11, FHWA-1P-89-016, 1989***.**
- *CALTRANS Highway Design Manual*
- *AASHTO Model Drainage Manual*

Instructions: To be used as guide for Hydraulic Studies and Reports

EXHIBIT 11-F DESIGN EXCEPTION FACT SHEET

DESIGN EXCEPTION FACT SHEET

Dist: _____ Date:_____

Co:_____ Prepared by:_____

Rte:_____

Project Cost:_____

1. Existing Conditions

2. Proposed Work and Non-Standard Features

3. Standard for Which Exception is Required

4. Accidents **3-year Period**

Total F F+I Actual Rate Expected Rate

Describe type(s) of accidents that are occurring and what effect the design exception is expected to have on them.

5. Design Year Traffic Volumes

6. Added Cost to Make Standard

7. Description of Any Additional Work to Enhance Safety

8. Reason for Requesting Exception

EXCEPTION APPROVED:_____DATE: _____

PUBLIC WORKS DIRECTOR *(OR DELEGATE TITLE)*

INSTRUCTIONS FOR " DESIGN EXCEPTION FACT SHEET'

1. Existing Conditions

Describe existing facility. Number of lanes, median width, shoulder width, etc. Describe width of adjoining sections if that information is relevant, for example on 3R projects.

2. Proposed Work and Non Standard Features

Describe work to be done. Resurfacing, shoulder widening, bridge widening, etc. Describe the non-standard design element that required the exception.

3. Standard for Which Exception is Required

Be specific. Name the source, i.e., 3R Criteria, *Instructions for AASHTO Green Book Implementation*, or *Highway Design Manual*.

4. Accidents **3-year Period**

Total F F+I Actual Rate Expected Rate

5. Design Year Traffic Volumes

If 3R project, use construction year. Otherwise, use design year usually 20-years in the future.

6. Added Cost to Make Standard

Show what it would cost to meet the standard for which the exception is being requested. If more than one quadrant is involved in the approach rail design request, cost shall be broken down on a per quadrant basis.

The Fact Sheet should also be accompanied with a detailed drawing of the bridge site along with topographical features (right of way lines, side road widths, physical obstructions, etc.) 30m from beginning and ending of the bridge.

7. Description of Any Additional Work to Enhance Safety

Mention any additional work which would qualify for safety enhancement such as median barrier, guardrail upgrade, slope flattening, super correction, elimination of roadside obstacles, additional lane and shoulder width, alignment improvement, etc.

8. Reason for Requesting Exception

Be thorough, but brief. These are some, but not all of the reasons exception has been granted in the past: high cost, environmental sensitivity, low accident rates, and postponement of bridgework.